CONTENTS

PUBLICATION POLICY

The *ECMWF Newsletter* is published quarterly. Its purpose is to make users of ECMWF products, collaborators with ECMWF and the wider meteorological community aware of new developments at ECMWF and the use that can be made of ECMWF products. Most articles are prepared by staff at ECMWF, but articles are also welcome from people working elsewhere, especially those from Member States and Co-operating States. The *ECMWF Newsletter* is not peer-reviewed.

Editor: Georg Lentze

Typesetting and Graphics: Anabel Bowen with the assistance of Simon Witter.

Any queries about the content or distribution of the *ECMWF Newsletter* should be sent to Georg.Lentze@ecmwf.int

Guidance about submitting an article is available at www.ecmwf.int/en/about/news-centre/media-resources

CONTACTING ECMWF

Shinfield Park, Reading, Berkshire RG2 9AX, UK

Fax:		+44 118 986 9450
Telephone:	National	0118 949 9000
	International	+44 118 949 9000
ECMWF website		www.ecmwf.int

Scalability challenge

Why is weather prediction so difficult? It's amazing that it can be done at all! It needs a huge volume of observations to describe the current state of the weather globally and an excellent scientific understanding of the laws of physics that govern the atmosphere (and oceans etc.). It needs numerical methods to solve the mathematical equations that describe the laws of physics and a supercomputer able to solve these equations in time for the forecast to be useful. It also needs data networks to disseminate the forecast data to users.

But arguably the part that is the most mysterious is the computer because it does something that is way beyond the capacity of the human brain. The computer is involved in all stages of the process, from the observational data handling at one end to the use of the forecasts by society at the other. Perhaps it is not surprising that to do this computers are complex to construct and consume significant amounts of energy.

How the computer works, how we present information to it, and how we formulate the equations for it to solve all make a real difference to the forecasts that are produced. To describe the computer as a tool is to diminish the significance of its role at the core of weather prediction. For example, we can be in the strange position of trying to inject an estimate of uncertainty into the equations the computer solves at the same time as requiring the computation to be done to an amazingly high level of precision. The future requires even more prodigious amounts of computing power to be at our disposal for forecasts to be at the level of detail, skill and confidence that users require.

We are reaching a computing crossroads where a new generation of computing systems with exascale capabilities promise much greater energy efficiency – but this will rely on parallel processing at levels to which current numerical weather prediction (NWP) codes are not adapted. Changes are needed throughout the entire NWP processing chain if we are to exploit these new opportunities for energy efficiency. The aim has to be to use the computer as effectively and efficiently as possible and in ways consistent with the kind of forecasts we want to create. In a nutshell, this is what the ECMWF Scalability Programme, launched in 2013, is aiming to do and it is a game-changer by any stretch of the imagination.

This programme is collaborative in so many ways – across member states, with computer vendors, with computer scientists, linking weather and climate modelling, etc. It brings together experts from around the world for a coordinated approach to hardware and software development. It is likely to result in a revolution – albeit a quiet one – in the way numerical weather prediction is done.

The key is to address the scalability challenge by using novel mathematical solutions and computing techniques. The programme's objectives are: an integrated forecasting system combining a flexible framework to apply the latest science with maximum achievable parallelism; portable code structures ensuring efficiency and code readability, and exploiting a range of expected future technologies; and metrics and a framework for code testing, allowing a quantitative assessment of scalability. The sky's the limit!

Alan Thorpe